Demand response in electricity distribution grids: a case study of the Flemish regulatory framework

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***Abstract*— Demand response for residential consumers is making a slow progression, despite its benefits towards various market participants, and the growing importance of distribution grids in light of the integration of distributed and renewable energy sources, and new demand applications. While some obstacles are techno-economic in nature, there also exist barriers related to regulation. The objective of this paper is to provide an overview of the Flemish regulatory framework concerning demand response, as well as to identify the main regulatory barriers to implementation for residential consumers. It is found that in some areas, the current regulatory framework is inadequate or incomplete. An analysis of the relevant literature allows to classify these barriers into six categories.**

***Index Terms*-- Demand Response, Distribution Grid, Regulation, Smart Grids**

I. INTRODUCTION

Historically, electricity markets in Europe were characterized by a top-down organization, with the generation side balancing the power system. During the 1990s, the European Union and its Member States decided to set in motion a process of liberalization and deregulation. Simultaneously, the traditional approach to system operation started changing towards a new paradigm: from a generation centered approach, to a market characterized by active demand involvement [1].

Nowadays, the demand side is increasingly participating. However, when demand response is implemented, it is primarily by large consumers trading on the wholesale market [2]. Although residential consumers possess ample flexibility, the current market model does not allow for it to be fully exploited [3]. Retail prices are generally fixed, reflecting average costs over longer time periods. Hence, they provide little cost-reflectiveness and limited price responsiveness.

At the same time, the importance of the distribution grid is growing steadily, because of the emergence of distributed and renewable generation (e.g. wind turbines and photovoltaics), as well as new demand applications (e.g. electric vehicles and heat pumps). Given the limited amount of electricity storage possibilities, demand response may play a significant role in dealing with the challenges related to consumption volatility, peak demand, and the variable nature of renewable generation.

The question now arises why residential demand response is not yet in place, and how it can be enabled. Although there undoubtedly exist techno-economic challenges, a great deal of the current stagnation can be explained by obstacles related to regulation.

The objective of this paper is to analyze the current regulatory framework concerning demand response in Flemish distribution systems. Additionally, the aim is to identify the different regulatory obstacles. Section II sets the scene by clarifying the concept of demand response and discussing the associated potential benefits. Section III then describes the relevant legal framework on both the European, the Belgian and the Flemish level. Section IV lists and examines the primary regulatory barriers to implementation which originate from this legal and regulatory framework. A last section concludes.

II. DEMAND RESPONSE: SCOPE AND BENEFITS

In academic literature, demand response is usually defined as a change in consumption patterns of electricity consumers in response to time-varying tariff structures or incentive payments in order to operate the electricity system in a more efficient and reliable way [1].

Demand response programs are typically classified into two main categories: price-based programs and incentive-based programs [4]. Fig. 1 provides an overview of each program and its subcomponents.

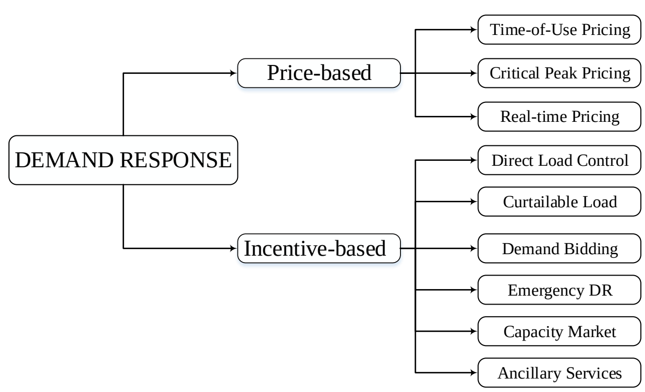

Figure 1. Demand response program categorization.

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In price-based programs, dynamic tariff structures reflect the actual cost of generating, transporting and supplying electricity [4]. Their aim is to shift consumption from periods where costs are high to periods where costs are low. In incentive-based programs, end-users receive payments for participating and for reducing their load at certain times. The different subcategories of both types of demand response programs are discussed in several research papers [4] [5].

The following classification of demand response benefits is made in academic literature [1]:

- Benefits towards participating consumers
- Market-wide benefits
- System reliability improvements
- Market performance benefits

By participating during peak hours, consumers can achieve electricity bill savings [1] [6].

Moreover, demand response programs are expected to lead to a market-wide electricity price reduction, because expensive peak plants have to be ramped up less frequently [1]. Additionally, grid infrastructure investments can be avoided or deferred [7]. Associated with the reduced deployment of peak plants and infrastructural investments is a society-wide environmental benefit. Studies suggest that EU-wide deployment of demand response by 2020 can create 100 TWh of annual energy savings and an annual environmental benefit of a 30 million tons CO_2 reduction [8].

Furthermore, demand response programs give grid operators more tools to deal with congestion issues and to safeguard system reliability and balance [9].

Demand response programs are also expected to improve electricity market performance by providing the market with more choices and opportunities for active participation, and by reducing concentration of market power through price responsiveness [10].

III. The Regulatory Framework

Just like any other sector, the power industry is subject to a collection of rules and principles. Regulation can be defined as a set of principles used to control, direct or manage an activity, an organization or a system [11]. This is based on the idea that free markets are subject to inefficiencies, making interference necessary.

Regulation is often confused with legislation, since the law and courts ultimately have the same objective. However, while legislation is enforced ex-post, regulation enforces the ‘rules of the game’ ex-ante.

At the same time, the law constitutes an important foundation for regulatory activities. For this reason, the most important legal provisions in the context of demand response programs in distribution systems are discussed in the following subsections. In particular, three policy levels are examined: international (the European Union), national (Belgium) and regional (Flanders).

A. *International: the European Union*

During the last decade, the European Union (EU) set in motion a process of restructuring and liberalization, emphasizing consumer protection against monopoly power and the threat of unjustifiably high prices or a lack of service quality. One of the primary goals of the European Union is the establishment of an internal energy market [12].

Additionally, the EU holds on to a trinity of electricity market objectives: security of supply, sustainability and competitiveness [13]. These high-level goals form the basis for most EU legislation concerning the electricity sector, and they are being reflected in the national laws of the Member States. The EU created several legally binding commitments, which are discussed below.

i. The 2020 Climate and Energy Package

In 2007-2008, The EU adopted a framework for greenhouse gas emission savings by 2020, the so-called ’20-20-20 targets’:

- An EU-wide reduction in greenhouse gas emissions of at least 20% below the level of 1990.
- An increase of EU-wide renewables generation to 20% of the associated consumption level.
- A 20% reduction in primary energy consumption compared to projected levels by means of energy efficiency.

Directive 2009/28/EC sets national targets concerning renewables generation. Note that, although this Directive does not specifically mention demand response, Art. 16§1 encourages Member States to take the necessary steps to make the grid more intelligent and to facilitate the integration of renewables [14].

An integrated policy framework for the periods up to 2030 and up to 2050 is currently being developed. This framework contains additional measures regarding greenhouse gas emissions, renewable generation, energy efficiency, emission rights, competition and security of supply [15]

ii. The Third Energy Package

This legal package was launched in 2009. Its aim was to further open up the European energy markets, with an emphasis on ownership unbundling and the creation of national regulatory authorities (NRAs). Two pieces of legislation are of particular importance:

- Directive 2009/72/EC: proposition of common rules for the internal market in electricity [16].
- Regulation 713/2009: establishment of the Agency for Cooperation of Energy Regulators (ACER) [17].

Directive 2009/72/EC does not propose demand response in a context of residential consumers. However, Annex 1§2 of this law compels all Member States to execute an 80% roll-out of smart meters by 2020, given a positive long-term cost-benefit analysis. These meters may play an important role in the implementation of demand response [18].

iii. The Energy-efficiency Directive

The aim of this Directive (2012/27/EU) is the development of a set of rules and measures for the promotion of energy efficiency [19].

This Directive mentions the importance of demand response as an instrument for energy-efficiency improvement [20]. Furthermore, it recognizes that demand response entails different subcategories and it mentions residential consumers in this context. Additionally, an aggregator is defined as "*a demand service provider that combines multiple short-duration consumer loads for sale or auction in organized energy markets"* [20].

iv. Privacy, data handling and consumer protection

Demand response goes hand in hand with increased consumption data processing, since it is crucial to measure the extent to which consumers adapt their behavior in response to signals.

On a European level, the primary piece of legislation regarding privacy is Directive 95/46/EG, which establishes rules on the protection of natural persons with respect to processing of personal data [21].

Furthermore, Art. 8 of the European Convention On Human Rights (ECHR) describes the right to respect for private life [22]. Also Art. 7 and Art. 8 of the Charter of Fundamental Rights of the European Union (2010/C 83/02) are related to privacy and data protection [23].

Lastly, ISO/CEI 27001 and ISO/CEI 27002 are international standards concerning information technology, security techniques and management systems for information security [24].

B. National: Belgium

i. The Electricity Act

The Electricity Act of April 29, 1999 covers the organization of the Belgian electricity market. In particular, it deals with centralized generation, the transmission system, power exchanges (Belpex), and the tasks of the national regulator CREG.

Despite several amendments, this law still does not directly deal with demand response for residential consumers, but Art 2, 27° defines the concept of energy-efficiency and demand side management as an integrated approach aimed at influencing the size and timing of electricity consumption so as to reduce peak load and primary energy consumption.

Furthermore, Art 8§1bis states that an economic analysis of the costs and benefits associated with smart meters has to be made by December 2012, following Directive 2009/72/EC.

ii. Privacy, data handling and consumer protection

In Belgium, the primary legislative act related to privacy is the Law of December 8, 1992. Together with this act, an independent organization was established, the Privacy Commission (CBPL), which monitors and enforces the practical application of the law.

The Privacy Law rules that personal data can only be used after explicit consent by the associated person, or when it is justified by the associated objectives. Art. 4 and 5 list numerous conditions under which personal data can be obtained and processed.

The principle of finality requires that data processers only collect data for well-defined and justified goals, and only use data in a compatible way with said objectives. The principle of proportionality, on the other hand, rules that personal data processing should always be restricted to the minimum required.

For all matters with respect to trading practices and consumer protection, consumers can rely on the law of April 6, 2010 (WMPC).

C. Regional: Flanders

i. The Energy Decree

This decree was approved in 2009 by the Flemish Government. Its primary objectives are (Art. 2.1.1):

- Guaranteeing the functioning of the Flemish electricity and gas market;
- Guaranteeing security of supply in Flanders;
- Stimulating energy-efficiency, energy savings and the development of sustainable energy sources;
- Facilitating the interconnection of energy networks.

Art. 3.1.1 and beyond deals with the creation and the tasks of the Flemish regulator VREG. In Belgium, the assignment of distribution system operators (DSOs), the bestowment of supply licenses, the creation of technical codes regarding distribution and policies concerning RES are all regional affairs. However, the determination of distribution grid tariffs is still a national endeavor. This will change in the course of 2014, following the so-called "Vlinderakkoord" [25].

The Energy Decree also provides a list of tasks attributed to the DSO (Art. 4.1.6). Art. 4.2.1 authorizes the VREG to formulate a separate technical code for electricity and gas DSOs.

Following European Directives, a number of metering-related articles have been added (e.g. the definition of a smart meter (Art. 1.1.3 113°/1)). Art. 4.1.22 /2 imposes a cost-benefit analysis on the Flemish government, due September 3, 2012. Installation, (de)activation, maintenance and the repair of meters is attributed to the DSO by Art. 4.1.6.

The Energy Decree does not comprise legally binding articles related to demand response. Art. 4.1.18/1 is currently being developed. Grid operators still have to collaborate with energy service companies (ESCOs), aggregators and consumers for the creation of technical specifications concerning participation of the demand side on balancing markets and other supporting services in distribution grids.

ii. Other documents of interest

After being approved in 2010, the Energy Resolution officially came into operation in January 2011. It bundles and substitutes all existing decisions related to energy policy. However, this act still does not mention demand response, nor smart metering.

Furthermore, the technical code for distribution grids contains general principles regarding exchange of data, confidentiality, procedures, as well as rules with respect to grid planning, grid access, measurement activities and collaboration between grid operators. It does not yet contain any provisions or procedures related to smart metering or demand response.

In the latest Flemish governmental agreement, the administration takes a positive stance on the roll-out of smart meters and the development of smarter electricity grids. With regard to smart meters, it seems that the question is not *if*, but rather *when* and *how* to proceed with a roll-out. “Flanders in action” is a collection of Flemish projects, bundled in “Pact 2020”, with the aim of moving Flanders towards a more sustainable and innovative environment. The administration has established a number of pilot projects to test a large-scale smart meter roll-out, and to analyze the associated long-term costs and benefits.

IV. REGULATORY BARRIERS TO DEMAND RESPONSE

In this section, a number of regulatory obstacles related to implementation of demand response in Flanders is discussed. While some of them may require little effort to solve, others pose a more fundamental problem. Fig. 2 provides an overview of six regulatory aspects which substantially impact the deployment of demand response.

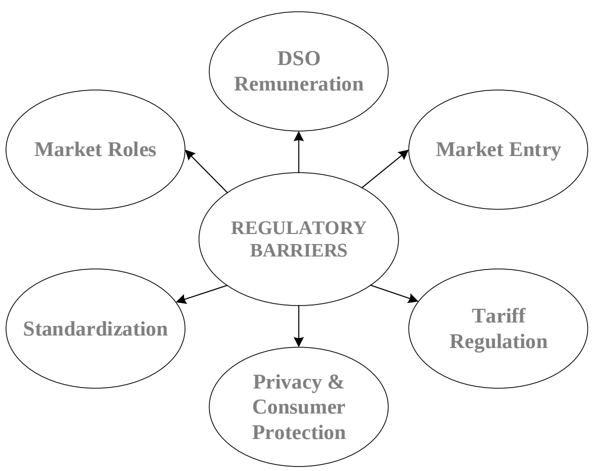

Figure 2. Overview of the primary regulatory barriers.

A. *Barriers related to DSO remuneration*

With respect to remuneration of distribution network activities, grid operators and utilities in Europe traditionally underwent ‘cost-of-service regulation’. This means that the regulator has to approve operational and investment expenses, demanding a minimum service quality and paying the associated costs in return via regulated tariffs charged to consumers [11]. While this ensures cost-reflective prices, a stable investment environment and security of supply, it creates a significant risk of cost-inflation due to asymmetric information and a lack of efficiency incentives.

For this reason, power market regulation is nowadays more incentive-based [11]. Retail Price Index regulation (RPI-X) in particular is the most common form. Under this mechanism, regulatory authorities set the maximum revenues or prices that grid operators are allowed to charge for a period of 4 to 5 years. These revenue caps are largely based on historical expenses and benchmarking techniques. They incentivize regulated players to be more cost-efficient, at the expense of lost cost-reflectiveness in prices [11].

With this type of DSO remuneration, a number of issues arise that negatively impact the development of innovative technologies in general, and demand response in particular.

- Revenue allowances are based on historically incurred costs [26]. Hence, little attention is given to future needs of the grid.
- Regulatory periods are relatively short (4 to 5 years). Outputs associated with certain inputs may not be realized in the same regulatory period. Because of this, companies are more incentivized to cut in OPEX (e.g. demand response pilots) than in CAPEX (e.g. grid expansion) [27] [13].
- When determining the allowed revenue base, regulators focus on benefits towards the DSO, rather than market-wide benefits associated with positive externalities (e.g. suppliers being able to use smart meters for sending price signals) [26].
- New investments experience a significant delay before they are recognized in the revenue base (i.e. the CAPEX time-shift problem) [26].
- Regulators use benchmarking techniques, reference networks and standard cost methods to assess cost-efficiency. R&D costs are often not accepted as efficient costs [13].

In Flanders, the regulator VREG will become responsible for distribution tariffs in the course of 2014, as a result of the sixth state reform [25]. Discussions on the adaptation of DSO remuneration and the tariff mechanism are now ongoing [28].

B. *Barriers related to tariff regulation*

The shift towards incentive-based regulation of DSOs was partly based on the idea that consumers should be protected against large price variations, and that improved cost-efficiency would reduce prices in the long run. Hence, distribution tariffs are typically flat and based on energy consumption volume.

Naturally, the current philosophy of flat tariffs makes grid operators and other investors reluctant to fund pilot projects for technologies that are based on variable pricing. Furthermore, this tariff methodology does not account for the fact that grid users and connected technologies are becoming increasingly complex.

One of the major problems related to current distribution grid tarification is that, by socializing most costs, it violates the principle of cost-causality, which states that agents should be charged in accordance with the costs they cause to the system. Furthermore, it does not account for the true drivers of distribution costs: geographical location, subscribed capacity, contribution to distribution peaks and contribution to system losses [13]. Instead, it erodes the level playing field between distribution grid connected agents by creating cross-subsidies.

Another important aspect to consider is the emergence of so-called electricity ‘prosumers’. Up until now, tariffs for residential consumers in Flanders typically focused on downstream electricity flows. This triggered a debate on the deployment of injection tariffs for distributed generation. As a result, since 2009 DSOs charge injection tariffs for all distribution grid connected generators with a capacity higher than 10kW [29].

C. Barriers related to market roles

As mentioned earlier, the most important Belgian and Flemish electricity market laws do not incorporate a clear definition of the responsibilities and competences of new participants such as aggregators and ESCOs. Yet, the development of these new intermediaries is crucial because, as opposed to supply side flexibility, demand side flexibility is not the 'core business' of consumers.

An important question that arises concerns the responsibility for investment in new ICT and metering equipment, the ownership of said infrastructure, and rules with regard to management of the associated data. Additionally, market players may be concerned about possible conflicts of interest or competition disturbances. Demand response has an important impact on the balancing exercise of BRPs, and ownership of infrastructure can significantly influence its roll-out and market competition. Smart meters, for instance, can be considered strategic assets, which can impede supplier switching when they are not owned by a regulated party such as the DSO.

Smart meter developments have also fueled the discussion on data handling responsibilities. Detailed consumption data can be a valuable commercial asset, and a clear division of roles is important to avoid potential abuse. In Belgium, the DSO is currently responsible for data management, but the debate on future changes is still ongoing. This may be the preferable alternative, since they are neutral, non-commercial and regulated entities, responsible for grid stability and security of supply. It can be argued that making them dependent on commercial parties for data availability is not preferable. Furthermore, they are easier to monitor and non-discriminatory to third parties, provided sufficient unbundling.

D. Barriers related to market entry

Current regulations typically impose minimum requirements on services in order to qualify for participation on wholesale markets such as the reserve market, the day-ahead markets and intra-day market. Examples of such requirements include: fixed trading charges (such as membership and entrance fees), minimum trading volume and minimum available capacity. For instance, the Belgian spot market (Belpex) requires membership costs of up to €25,000 for full access [30]. These trading conditions may impede the ability of (smaller) aggregators to participate. Hence they restrict the development of demand response services.

Another relevant issue in this context is the lack of unbundling. Despite European liberalization efforts, markets are still highly concentrated, with more than half of European DSOs not being unbundled [13]. In Belgium, 21% of the Flemish DSO Eandis is still owned by Electrabel nv, a private company active in generation and supply of electricity and gas [31]. Insufficient unbundling of DSOs can effectively block competition on the retail market [32].

Electricity markets are also still highly concentrated. In several countries, more than 80% of generation is still controlled by former incumbents [33]. This means that the existing supply-side flexibility can benefits from scale economies, which makes participation by demand-side flexibility sources more difficult.

E. Barriers related to standardization

Despite the fact that standardization of products and services has an important impact on investment interest and market competitiveness and liquidity, there is a lack of EU-wide and national standardization. For example, although the EU communicated its opinion on smart meter functionalities, there are still no legally binding minimum requirements [34].

Furthermore, there is a need for clear legal definitions of new smart grid concepts. For example, neither the Energy-efficiency Directive, nor Belgian and Flemish legal acts provide a comprehensive definition of the term 'smart grid', which leaves freedom to decide on the interpretation [20].

It is important to recognize that many important technologies are already available, but that the true challenge may lie in their interoperability and in the integration in existing infrastructure.

In recent years, CEN, CENELEC and ETSI have been working on the development of a set of standards for smart meters, smart grids and communication protocols, based on EC mandates M/441 and M/490.

F. Barriers related to privacy and consumer protection

Although there exists a broad legal framework on privacy and data security on the EU level, there is a lack of sector-specific rules in the context of demand response. This may hamper not only investment interest but first, and foremost, consumer acceptance. Current regulations are designed to support data processing for billing purposes, which takes place only a few times per year.

In the Belgian privacy law, personal data is defined as data referring to directly or indirectly identifiable natural persons (Art. 1§1). In a context of smart meters for instance, this definition is quite broad, since it applies to all information that can be linked to a single and unique meter number (EAN-number), which is in turn linked to a consumer.

Because privacy law is prone to interpretation, and because of a lack of clear rules regarding confidentiality, data handling and security, investors are not incentivized to proceed with a smart meter roll-out. An EU-wide framework may create more regulatory stability for investors, as well as bolster demand response acceptance by the European consumer.

V. Conclusion

This paper analyzes the regulatory framework regarding demand response in Flemish distribution systems, describing the most important regulatory principles and legal provisions on several policy levels (European, Belgian and Flemish). It is found that national and regional legislation in Belgium is significantly impacted by the European legal framework in general, and the Third Energy Package, the Energy-efficiency Directive and the 20-20-20 targets in particular.

Six categories of regulatory barriers with respect to implementation of demand response are identified. It is found that that current DSO revenue allowance mechanisms and grid tarification methods are inherently flawed in supporting innovation and in creating a level playing field among grid users. Furthermore, the development and roll-out of new technologies is being hindered by a lack of clear roles and responsibilities regarding infrastructural investments and new services, a lack of standardization, and the existence of market entry barriers such as minimum capacity or trading volume requirements. Finally, it is found that the absence of a clear, sector-specific framework regarding privacy and data security limits the acceptance of new demand response technologies by investors and consumers alike.

It can be concluded that a significant overhaul and expansion of the regulatory framework may be necessary to spur both industry and consumer interest in demand response. While slow progression can be justified by technological or economic limitations, it is imperative to remove some artificial barriers such as those created by regulatory constraints. A major challenge in this regard is streamlining the Flemish framework with the European regulatory model while still accounting for local needs and differences.

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